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(54) [Title of the Invention]

OPTICAL TRANSMISSION ELECTRONIC CIRCUIT SUBSTRATE AND OPTICAL TRANSMISSION ELECTRONIC CIRCUIT SUBSTRATE DEVICE

(57) [Abstract]

[Object]

To provide an optical transmission electronic circuit substrate device that is capable of giving transmission light directly from a light-emitting side to plurality of photo-detecting sides.

[Means for Solving]

A plurality of optical transmission electronic circuit substrates 21, 31, and 41 are disposed to be stacked in multiple stages, wherein photo-detecting sections 22a are formed in a part of a transparent glass substrate section 23 of the substrate 21, photo-detecting sections 32a are formed in a part of a transparent glass substrate section 33 of the substrate 31 so as not to overlap with the photo-detecting sections 22a, and photo-detecting sections 42a are formed in a part of a transparent glass substrate section

43 of the substrate 41 so as not to overlap with the photo-detecting sections 22a and 32a, non-phot-detecing section regions of each transparent glass substrate section are light transmitting regions, and light emitted from corresponding light-emitting sections 12a of a light-emitting element array 12 provided over an optical transmission electronic circuit substrate 11 reaches the respective photo-detecting sections 22a, 32a, and 42a over the optical transmission electronic circuit substrates 21, 31, and 41.

[Scope of Claims]

[Claim 1]

An optical transmission electronic circuit substrate characterized by comprising:

an electronic circuit region mounted with an electronic circuit;

a photo-detecting region provided with a photo-detecting element; and

a light transmitting region to pass light.

[Claim 2]

The optical transmission electronic circuit substrate according to Claim 1 characterized in that:

the optical transmission electronic circuit substrate includes a transparent substrate section,

the photo-detecting element is formed in a part of the transparent substrate, and

a non-formation region of the photo-detecting element comprises the light transmitting region.

[Claim 3]

An optical transmission electronic circuit substrate device characterized in that:

the optical transmission electronic circuit substrate according to Claim 1 or Claim 2 is disposed to be stacked in multiple stages;

a photo-detecting section is formed in a part of each substrate, corresponding to a formation region of a light-emitting element of another substrate; and

light of the corresponding light-emitting element among the plural light-emitting elements reach each photo-detecting element of the optical transmission electronic circuit substrate disposed to be stacked in multiple stages.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to an optical transmission electronic circuit substrate and an optical transmission electronic circuit substrate device having an optical data bus line used for an optical computer and the like.

[0002]

[Prior Art]

FIG. 3 is a perspective view showing an optical transmission electronic circuit substrate device having a conventional optical data bus line. The optical transmission electronic circuit substrate device, which comprises optical transmission electronic circuit substrates 51 and 61, performs data transmission in which data generated in electronic circuits 55 provided over one optical transmission electronic circuit substrate 51 is transmitted to electronic circuits 65 provided over the other optical transmission electronic circuit substrate 61 through an optical data bus line.

[0003]

In other words, the optical transmission electronic circuit substrate 51 includes a light-emitting element array 52, and emits light for data transmission from an arbitrary light-emitting section 52a of the light-emitting element array 52 toward the other optical transmission electronic circuit substrate 61. The other optical transmission electronic circuit substrate 61 includes a photo-detecting element array 62 in which photo-detecting sections 62a are disposed corresponding to respective light-emitting sections 52a of the light-emitting element array 52, and data is obtained when the light is received at an arbitrary photo-detecting section 62a.

[0004]

[Problem to be Solved by the Invention]

However, as for the conventional optical transmission electronic circuit substrate device described above, data transmission using light can be performed only one-to-one, that is, only between an optical transmission electronic circuit substrate 51 and an optical transmission electronic circuit substrate 61. Accordingly, it is necessary that all processing circuits, which use data transmitted from the optical transmission electronic circuit substrate 51, is provided over the optical transmission electronic circuit substrate 61. Therefore, the optical transmission electronic circuit substrate 61 must be equipped with a lot of electronic circuits 65; thus, the size of the substrate becomes large and the size of the device can not be reduced. In addition, delay of a signal and electromagnetic radiation which are caused because a wiring gets longer might have adverse effects on the operation.

[0005]

Then, it is conceivable that one-to-plural optical data transmission, in which a light-emitting side is "1" and photo-detecting sides are "plural", is performed by providing a light-emitting element array over the optical transmission electronic circuit substrate 61; converting data, which has been converted into an electrical signal at the photo-detecting element array 62, again into transmission light at the light-emitting element array 62; and emitting the transmission light toward another optical transmission electronic substrate not shown which is disposed to be stacked at the upper part of the drawing of the optical transmission electronic circuit substrate 61. However, in this case, the optical transmission electronic circuit substrate 61 includes a light-emitting element array only for relaying transmission light. Thus, not only the cost rises but also the size becomes larger in accordance with the number of light-emitting element arrays provided over the optical transmission electronic circuit substrate 61.

[0006]

In view of the above circumstances, the present invention is aimed at providing an optical transmission electronic circuit substrate and an optical transmission electronic circuit substrate circuit, by which one-to-plural optical data transmission is realized at low cost with small size by giving light emitted from a light-emitting element array directly to respective optical transmission electronic circuit substrates arranged in multiple stages.

[0007]

[Means for Solving the Problems]

An optical transmission electronic circuit substrate according to the present

invention is characterized by having an electronic circuit region mounted with an electronic circuit, a photo-detecting region provided with a photo-detecting element, and a light transmitting region to pass light. In addition, the above structure may include a transparent substrate section with the photo-detecting element formed at a part of the transparent substrate, and a non-formation region of the photo-detecting element includes the light transmitting region. Here, when the optical transmission electronic circuit substrate is an opaque substrate, it is sufficient that an opening is formed therein and a transparent substrate section is mounted and fixed in the opening. Further, when the optical transmission electronic circuit substrate itself is transparent, since the substrate serves as a transparent substrate section, a photo-detecting element may be directly provided over the substrate.

[0008]

The optical transmission electronic circuit substrate device according to the present invention is characterized in that a plural of optical transmission electronic circuit substrate having the above structure is disclosed to be stacked in multiple stages; a photo-detecting section is formed in a part of each substrate, corresponding to a formation region of a light-emitting element of another substrate; and light of the corresponding light-emitting element among the plural light-emitting elements reach each photo-detecting element of the optical transmission electronic circuit substrate disposed to be stacked in multiple stages.

[0009]

With the above structure, data, which the first stage optical transmission electronic circuit substrate provided on the side nearest to a light-emitting element array

needs, may be directly received when the photo-detecting element provided in the optical transmission electronic circuit substrate receives the light from the light-emitting element array. Data, which the second stage optical transmission electronic circuit substrate provided in a stage subsequent to the first stage optical transmission electronic circuit substrate needs, may be directly obtained when the photo-detecting element provided in the second optical transmission electronic circuit substrate receives transmission light through the light transmitting region in the first stage optical transmission electronic circuit substrate. In the same manner, subsequent optical transmission electronic circuit substrates such as the third stage or the forth stage can also receive data directly by receiving transmission light through the light transmitting region of the optical transmission electronic circuit substrate of the precedent stage.

[0010]

Thus, one-to-plural optical data transmission in which the emitting side is "1" and the photo-detecting sides are "plural" can be carried out. Accordingly, the number of processing circuits which should be mounted on the respective optical transmission electronic substrates is reduced, so that the size of a substrate can be reduced. Accordingly, the miniaturization of the device can be realized by stacking a plurality of such substrates in multiple stages. In addition, since the light-emitting element array is not mounted on the optical transmission electronic circuit substrate only for relaying transmission light, it is possible to prevent increase in costs and size which are caused by providing the light-emitting element array.

[0011]

Moreover, the light transmitting region can be obtained by merely forming a

small through-hole corresponding to the size of each photo-detecting section in the photo-detecting element array, over the substrate. However, there is apprehension that failure occurs in the process of forming the through-hole and the through-hole may cause the deterioration in the strength of the substrate. As above, by using the transparent substrate section for the light transmitting region, it is possible to prevent detection in the strength of the substrate besides eliminate the process of forming the through-hole. Accordingly, it is preferable to use the transparent substrate section.

[0012]

[Embodiment Modes of the Invention]

Embodiment modes of the present invention will be hereinafter described with reference to the drawings.

[0013]

FIG. 1 is a perspective view showing an optical transmission electronic circuit substrate device according to this embodiment mode. The optical transmission electronic circuit substrate device, which comprises optical transmission electronic circuit substrates 11, 21, 31, and 41, performs data transmission in which data generated at electronic circuits 15 provided over the optical transmission electronic circuit substrate 11 is transmitted to electronic circuits 25, 35, and 45 provided over the other optical transmission electronic circuit substrates 21, 31, and 41 with optical data bus lines.

[0014]

The optical transmission electronic circuit substrate 11 includes a light-emitting element array 12 and emits transmission light for data transmission from an arbitrary

light-emitting section 12a of the light-emitting element array 12 toward the other optical transmission electronic circuit substrates 21, 31, and 41. The light-emitting element array 12 is formed by using an infrared plane emission laser diode driven independently as the light-emitting section 12a (wavelength 860 nm) and providing the light-emitting sections 12a in 3 × 3 arrangement with 300 μm spacing. A collimating lens array 9 for making light emitted from each light-emitting section 12a into parallel light is disposed at the front side of the light-emitting element array 12.

[0015]

The optical transmission electronic circuit substrate 21 includes an electronic circuit region mounting an electronic circuit 25, a photo-detecting region in which a photo-detecting element array 22 is formed, and a light transmitting region consisting of a transparent glass substrate section 23 mounted and fixed in an opening not shown. The electronic circuit 25 is connected to the photo-detecting element array 22 with wirings 26. The photo-detecting element array 22 is formed to have three photo-detecting sections 22a corresponding to three light-emitting sections 12a among respective light-emitting sections 12a of the light-emitting element array 12, and obtains data from the optical transmission electronic circuit substrate 11 by means of these photo-detecting sections 22a receiving transmission light.

[0016]

The photo-detecting sections 22a are formed using parts of the whole region over the transparent glass substrate section 23. In the region of the transparent glass substrate section 23, the region over which the photo-detecting sections 22a are not formed is considered as a light transmitting region. The light transmitting region may

be formed with a through-hole, however, since the transparent glass substrate section 23 is used as a light transmitting region, the process of forming a through-hole is unnecessary and degradation in the strength of a substrate which is caused by forming through-hole can also be prevented.

[0017]

The optical transmission electronic circuit substrate 31 includes an electronic circuit region mounted with the electronic circuits 35, a photo-detecting region in which a photo-detecting element array 32 is formed, and a light transmitting region consisting of a transparent glass substrate section 33 mounted and fixed in an opening not shown. The electronic circuits 35 are connected to the photo-detecting element array 32 with wirings 36. The photo-detecting element array 32 is formed to have three photo-detecting sections 32a corresponding to three light-emitting sections 12a (except the one corresponding to the optical transmission electronic circuit substrate 21) among respective light-emitting sections 12a of the light-emitting element array 12, and obtains data from the optical transmission electronic circuit substrate 11 by means of these photo-detecting sections 32a receiving transmission light. The photo-detecting sections 32a are formed using a part of whole region over the transparent glass substrate section 33. In the region of the transparent substrate section 33, the region over which the photo-detecting sections 32a are not formed is considered as a light transmitting region.

[0018]

The optical transmission electronic circuit substrate 41 includes an electronic circuit region mounted with the electronic circuits 45, a photo-detecting region in which

a photo-detecting element array 42 is formed, and a light transmitting region consisting of a transparent glass substrate section 43 which is mounted and fixed in an opening not shown. The electronic circuits 45 are connected to the photo-detecting element array 42 with wirings 46. The photo-detecting element array 42 is formed to have three photo-detecting sections 42a corresponding to three light-emitting sections 12a (except the ones corresponding to the optical transmission electronic circuit substrate 21 and the optical transmission electronic circuit substrate 31) among respective light-emitting sections 12a of the light-emitting element array 12, and obtains a data from the optical transmission electronic circuit substrate 11 by means of these photo-detecting sections receiving transmission light. The photo-detecting sections 42a are formed using a part of the whole region over the transparent glass substrate section 43. In the region of the transparent glass substrate section 43, the region over which the photo-detecting sections 42a are not formed is considered as the light transmitting region.

[0019]

FIG. 2 is a perspective view showing one photo-detecting section 22a (32a, 42a) formed over the transparent glass substrate section 23 (33, 44). As for a material to form the transparent glass substrate section 23, quartz glass (thickness of about 1 mm) is used. In addition, photo diodes or photo transistors may be used for the photo-detecting sections 22a; however, an example of using a photoconducting photo detector is described here.

[0020]

To form the photo-detecting element array 22 including a photoconducting photo detector, for example, an undoped amorphous silicon (a-Si) film is formed by a

CVD method to the thickness of about 1 μm over a transparent glass substrate and an unnecessary portion is removed by RIE (reactive ion etching method) in accordance with a photo-detecting section pattern. At this time, etching is carried out so that the photo-detecting section is 200 × 200 μm^2. Subsequently, an electrode material is formed over the a-Si film by vacuum vapor deposition, and electrodes 8 are formed by using a photolithography process. Al is used as the electrode material. In addition, a line width of the electrodes 8 over the a-Si film is 5 μm, the spacing between lines is 10 μm, and the number of the lines is 9.

[0021]

Next, as to the optical transmission electronic circuit substrate formed as above, operation of data transmission by light will be explained.

[0022]

When data generated by the electronic circuits 15 of the optical transmission electronic circuit substrate 11 is supplied to the light-emitting element array 12 via the wirings 16, transmission light is emitted toward the optical transmission electronic circuit substrates 21, 31, and 41 by an arbitrary light-emitting section 12a of the light-emitting element array 12. The emitted transmission light passes through the light transmitting region when it reaches the light transmitting region and is caught by the photo-detecting section when it reaches the photo-detecting section.

[0023]

Data that the first stage optical transmission electronic circuit substrate 21 disposed on the side nearest to the light-emitting element array 12 needs can be directly received when the photo-detecting section 22a of the photo-detecting element array 22

mounted on the optical transmission electronic circuit substrate 21 receives transmission light generated from the light-emitting section 12a of the light-emitting element array 12.

[0024]

In addition, a data that the second stage optical transmission electronic circuit substrate 31 which is provided at a stage subsequent to the first stage optical transmission electronic circuit substrate 21 needs can be directly obtained when the photo-detecting element 32 mounted the optical transmission electronic circuit substrate 31 receives transmission light which has passed through the light transmitting region 23 of the first stage optical transmission electronic circuit substrate 21.

[0025]

In the same manner, the third stage optical transmission electronic circuit substrate 41 can also receive data directly by receiving transmission light which has passed through the light transmitting region 23 of the optical transmission electronic circuit substrate 31 of the precedent stage.

[0026]

Thus, one-to plural optical data transmission in which the emitting side is "1" and the photo-detecting sides are "plural" can be conducted. Accordingly, the number of processing circuits which should be mounted on the optical transmission electronic circuit substrate to be a photo-detecting section is reduced, so that the size of a substrate can be reduced. Accordingly, the miniaturization of the device can be realized by stacking a plurality of such substrates in multiple stages. In addition, since the light-emitting element array is not mounted on the optical transmission electronic circuit

substrate only for relaying transmission light, it is possible to prevent increase in costs and size which are caused by providing the light-emitting element array.

[0027]

Note that the substrates 11, 21, 31, and 41 are, for example, opaque substrates such as a substrate made of epoxy resin in the above embodiment mode. In this case, openings (which are not shown) are provided over the substrates 21, 31, and 41, and the transparent glass substrate sections 23, 33, and 43 are placed over the opening. However, the openings are not required when the substrates 21, 31, and 41 are, for example, transparent glass substrates. Further, in the case the where substrates 21, 31, and 41 each consist of a transparent substrate, the photo-detecting elements 22, 32, and 42 may be directly provided over the substrates 21, 31, and 41 without using the transparent glass substrate sections 23, 33, and 43.

[0028]

In addition, it is conceivable that a light-emitting element array is provided over the optical transmission electronic circuit substrate 41, a light transmitting section is provided in the optical transmission electronic circuit substrate 31, and a photo-detecting element array is provided over the optical transmission electronic circuit substrate 21 so that the optical transmission electronic circuit substrate 41 transmits data processed with its electronic circuit to the other optical transmission electronic circuit substrate 21.

[0029]

Moreover, the optical transmission electronic circuit substrate according to the present invention, for example, may be used for an optical computer in the form of an

expansion slot, and may also be used in the form of an IC card. Further, a plural of optical transmission electronic circuit substrates may be accommodated in one package so that plural optical transmission electronic circuit substrates are formed outwardly like one circuit substrate by containing into one package.

[0030]

[Effect of the Invention]

As described above, according to the present invention, the number of processing circuits which an optical transmission circuit substrate should include is reduced and a substrate size is reduced; thus, miniaturization of the device can be realized. In addition, a light-emitting element array is not mounted on the optical transmission electronic circuit substrate only for relaying transmission light; therefore, the effect of preventing the increase in cost and size which are caused by providing the light-emitting element array can be exerted.

[Brief Description of Drawings]

[FIG. 1] a perspective view showing an optical transmission electronic circuit substrate device according to the present invention.

[FIG. 2] a perspective view showing one photo-detecting section formed in a part of a transparent glass substrate section according to the present invention.

[FIG. 3] a perspective view showing a conventional optical transmission electronic circuit substrate device.

[Description of the References Symbols]

11, 21, 31, 41: optical transmission electronic circuit substrate,

12: light-emitting element array,

12a: light-emitting section,

15, 25, 35, 45: electronic circuit,

22, 32, 42: photo-detecting element array,

22a, 32a, 42a: photo-detecting section,

23, 33, 43: transparent glass substrate section

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